Bionic Inspired High Stressable Joints for Multi-material Constructions with FRP and Metals

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The principle of hybrid design allows the construction of optimized lightweight structures, which can comply with the increasing demands for components with high power density. The trend is particularly pronounced in automotive industry, whereby the use of thermoplastic fiber reinforced thermoplastics (FRP) offers several advantages in specific characteristics and manufacturing properties. In conjunction with classical isotropic materials - such as steel or aluminum – FRP can be manufactured to lightweight structures in multi-material-design (MMD) with a high load capacity.

By the use of pre-consolidated hybrid laminates – consisting of FRP plies combined with metallic foils – hybrid components can be produced in automotive mass production under the use of conventional production systems for metal processing. However, increased research is needed in load adjusted joining processes for structural MMD vehicle components, to meet the needs of the divergent lightweight materials. In particular, the structural design and the anisotropy of FRP contained in the hybrid laminates necessitates an optimized design of the joint, to fully exploit the high lightweight potential of this class of materials.

The innovative joining technology Thermomechanical Flowforming (in german: Thermomechanisches Ausformfügeverfahren) – developed at the Institute of Lightweight Structures (IST) of Technische Universität Chemnitz – combines metal- and FRP- thermoforming processes. The new approach enables the fault tolerant and reproducible joining of these various material systems for the first time. Due to the fiber realignment at the FRP load introduction zone a high stressable force flux optimized design of the joint is achieved, whereby no additional joining element is required which suffers significant advantages in weight and costs.

Using the example of automotive-related applications and material combinations such as hot-dip coated steel HX260LAD, carbon fiber reinforced polyamide 6 as well as hybrid laminates comprehensive experimental strength studies were carried out to characterize the properties of the new TAF-joining system.

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